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ANALYSIS OF DEFENSE LANGUAGE INSTITUTE
AUTOMATED STUDENT QUESTIONNAIRE DATA

by

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The method of principal components is used to derive initial factors. Although an interpretation of those factors seems plausible, they are subjected to a factor analysis rotation (varimax) and five factors are determined and interpreted. Each of the five factors are interpreted in terms of student satisfaction with DLI's: (1) *academic environment*, (2) *military environment*, (3) *non-barracks dormitory living conditions*, (4) *official and supplemental course audio tapes*, and (5) *service unit's computer learning centers*. From the factor loading matrix factor scores equations are developed for use in a sub-scale trend analysis.

Using non-parametric procedures, each factor is checked for differences in central tendency by sex, pay grade, and DLPT score (DLPT consists of three tests DLPTL, DLPTR, DLPTS). From this analysis the following results derive: (1) sex has no effect on any of the factors, (2) pay grade affects satisfaction with the military environment, (3) DLPTL, DLPTR, and DLPTS affect satisfaction with the academic environment, and DLPTS also affects satisfaction with the computer learning centers.

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ANALYSIS OF DEFENSE LANGUAGE INSTITUTE AUTOMATED STUDENT QUESTIONNAIRE DATA

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of the requirements for the degree of

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TABLE OF CONTENTS

I. INTRODUCTION

This chapter provides some background on the Defense Language Institute (DLI) then addresses the problem this thesis treats and the methodology employed.

A. BACKGROUND

This section briefly describes DLI's mission, vision, goals, student population, entrance requirements, language assignments, and proficiency standards. The genesis of their primary student feedback tool, the Automated Student Questionnaire, (ASQ) is also presented.

1. DLI – Mission, Vision, and Goals

DLI's home page describes their mission in the following way: "To *train*, *sustain*, and *evaluate* foreign language skills..." As the world's "...largest..." and "...most respected language resource institute..." their vision for the 21st Century is to remain "...flexible and responsive to the changing world order and on the cutting edge of technical innovations..." From their goals statement, those germane to this thesis are as follows: (1) **Training** – 80% of students achieve level two proficiency in listening, reading, and speaking, (2) **Evaluating** – develop valid and reliable assessment tools, (3) **Quality Philosophy** – create a culture of continuous quality improvement, (4) **Quality of Life** – develop and maintain affordable quality of life programs that allow students to focus on learning.

2. Student Population

Each year the Defense Language Institute trains thousands of military, DOD, and civilian personnel in a wide variety of foreign languages. The Institute plans for 2,900 students annually and since its inception in 1941 has graduated more than 155,000. This student population is screened for a minimum *aptitude* level prior to enrollment at DLI. Military students are first screened for minimum language aptitude via the Armed Services Vocational Aptitude Battery (ASVAB). Those that pass the ASVAB's language aptitude

section are then evaluated with the Defense Language Aptitude Battery (DLAB). The DLAB is based on an artificial language and is designed to measure the student's ability to learn foreign language in general, not his/her ability to learn a specific foreign language.

3. Language Assignment

Students are assigned to a specific language based on their DLAB score. Once assigned, the specific course of instruction varies in length and difficulty depending on the language. Languages are categorized on a difficulty scale ranging from one to four. A category one language is a close cognate of the student's native language (assumed to be English) such as Spanish or French. These languages have common words, similar sounds, sentence structure, and recognizable symbols (letters). In contrast, category four languages are considered "truly" foreign languages and essentially have nothing in common with English. Currently 24 languages and dialects are taught and they are organized into seven different language schools: Asian 1, Asian 2, Middle Eastern 1, Middle Eastern 2, East European 1, East European 2, and West European/Latin American. These schools are organized into departments that employ the Team Teaching Concept with teams of six instructors responsible for three groups of about ten students each.

4. Completion of Training

Upon completion of training, students are evaluated for language *proficiency* by another standardized test, the Defense Language Proficiency Test (DLPT). The DLPT is best considered as three separate tests: (1) DLPT**L**, for "listening," (2) DLPT**S**, for "speaking," and (3) DLPT**R**, for "reading." For each of the three, the scale on which proficiency is recorded is an eleven point scale (0, 0+, 1, 1+, 2, 2+, 3, 3+, 4, 4+, 5) on which zero represents no proficiency at all and five represents a proficiency level associated with a native speaker. As noted in the goals statement, the targeted achievement level for the institution is that 80 percent of the students score *two* or better on each of DLPTL, DLPTS, and DLPTR. This targeted achievement level can be roughly

equated to the proficiency level expected from a college language major after two full years of study.

5. The ASQ

Upon completion of the training process the students are required to provide input as to their perception of quality with regard to their overall DLI experience. The data collection instrument has traditionally been survey type forms. These surveys evolved from paper and pencil to their current fully automated configuration called the ASQ. There are two versions of the ASQ, ASQ 1.0 introduced in March of 1993, and the current version, ASQ 2.0, implemented in December 1995. Files with ASQ 1.0 data contain approximately ten thousand records while files with ASQ 2.0 data contain fewer records and number approximately one thousand. Data from both ASQ's are accessible and can be linked to various other respondent items such as: pay grade, class number, service component, sex, DLAB, and DLPT score.

The ASQ's purpose is to collect student opinion data on the overall quality of their DLI experience. This task is facilitated by dividing the ASQ into two parts, each aimed at collecting data on one of two aspects of the students' entire DLI experience, these aspects are as follows: (1) Instructional Effectiveness (IE) and (2) Program Effectiveness (PE).

a) ASQ 1.0

ASQ 1.0 is further divided into sub-categories within IE and PE. Each of these sub-categories attempts to capture student opinion on a particular *dimension*. These *dimensions* are designed on an intuitive basis and are not disclosed to the respondent during the data collection process. Each main category of IE or PE is divided into five to eight sub-categories, where each sub-category is supported by one to nine questions. For example, one of the sub-categories under IE is "Counseling and Assistance" which is supported by three questions which are shown below:

(1) Went out of his or her way to help me learn the Language.
(2) Gave me helpful, individual feedback when I needed it.
(3) Was readily approachable for counseling or assistance when I needed it.

b) ASQ 2.0

The total number of questions and the number of sub-categories in both IE and PE are reduced in ASQ 2.0. For the new PE there are now fourteen questions that are believed to support only two broad sub-categories: *academic* and *military*. The new IE arrangement is similarly transformed.

6. Other Feedback Sources

DLI staffs internal evaluation teams in the form of Training Assistance Visits (TAV) and hosts external committees to aid them in the curriculum review process. TAVs and curriculum reviews are expected to provide information leading to better understanding of root causes of problems experienced by students. TAV reports are qualitative descriptions of the school's management practices, procedures, and their impact on the training program.

Curriculum reviews were conducted only up to the fall of 1993; however, staffing and procedures for re-establishing a revised version of the curriculum review are now under discussion. The primary function of the curriculum review was to furnish the customer agencies that use DLI graduates a first hand look and direct input into the language programs.

B. PROBLEM STATEMENT

In accordance with the Institute's goals of "continuous quality improvement" and maintenance of "valid and reliable assessment tools," DLI staff is evaluating student feedback as an indicator of Program and Instructor Effectiveness. They want to know if their ASQ really measures the underlying phenomena it purports to measure. Specifically, with respect to ASQ 2.0:

(1) Do ASQ 2.0's 14 questions support the *two* sub-category design?

(2) If not, what is ASQ 2.0's dimensionality and which questions represent those dimensions?

Additionally, DLI's Research and Analysis Division would also like to see some analysis of the ASQ 2.0 responses to determine if student satisfaction levels appear to depend on pay grade, sex, or DLPT scores.

C. METHODOLOGY

First the ASQ 2.0 data are analyzed to determine the number of separate underlying mathematical factors that account for the variability in the data set, in other words, to determine the mathematical dimensionality. This is accomplished using the method of principal components. Once the principal components are determined, a factor analysis is performed in an attempt to improve the interpretations of the components or factors. The number of factors are then compared to the number of dimensions believed to be designed into the questionnaire. The dimensional design was not disclosed to the author until after the factor analysis was completed and interpretations made. The mathematical factors are qualitatively analyzed to examine whether they make intuitive sense as well.

II. DIMENSIONALITY ANALYSIS

This chapter presents an analysis of the ASQ 2.0 PE data. The 14 questions (variables) are first analyzed for pairwise correlation followed by principal components analysis. Several methods for eliminating components are discussed; then, using a composite of those methods seven of the fourteen principal components are eliminated and five of the remaining seven are interpreted. Various numbers of components are retained and subjected to the varimax factor analysis rotation scheme and subsequent interpretation of the rotated factors is presented. The varimax factor analysis rotation maximizes the sum of the squared correlations for retained components thereby producing a unique rotation matrix which, when multiplied by the original matrix of eigenvectors, produces a unique factor matrix.

A. THE DATA

As stated in the introduction, the variables of this data set are the responses to questions concerning program effectiveness at DLI, and the respondents are DLI students.

1. The Variables

There are fourteen variables and the response to each is an integer in the range 0-4. The responses represent the students' opinions on various aspects of their entire DLI experience. For each question the possible responses are:

(1) "0" No opinion or not applicable

(2) "1" Strongly Disagree

(3) "2" Disagree

(4) "3" Agree

(5) "4" Strongly agree

All questions are worded so that the higher number response relates to the question in a positive way, e.g., "The *course objectives were* ***clearly*** *explained* to

me early in the program." rather than, "The *course objectives were **not** well explained*." Therefore, for all questions a higher number is interpreted as *better* than a lower number. The entire set of questions is shown in Figure 1.

1. The overall instructional program for my language was well organized.
2. The overall program goals and related requirements were clearly explained.
3. Teaching team cooperation fostered an effective learning environment.
4. The grading system was clearly explained early in the program.
5. The official course tapes had good sound quality.
6. The official text materials were useful.
7. Course tests appropriately measured my ability.
8. Supplemental (instructor-prepared) language tapes had good sound quality.
9. My service unit's computer learning center was helpful in supporting my study program.
10. My barracks/dormitory was comfortable and well maintained.
11. My government housing was comfortable and well maintained.
12 The quality of the food in the dining facilities was good.
13. My military training at DLI contributed to my overall development.
14. The care I received at the Troop Medical Clinic was responsive to my needs.

Figure 1: ASQ 2.0 Questions

2. The Respondents

The set of respondents for this study consists of 615 DLI students. All students are unique in that each contributes only one set of responses to the data base. The students in the data base are summarized by pay grade and sex in Figure 2. The vertical axis contains pay grade-sex combinations and the horizontal axis is the number of respondents.

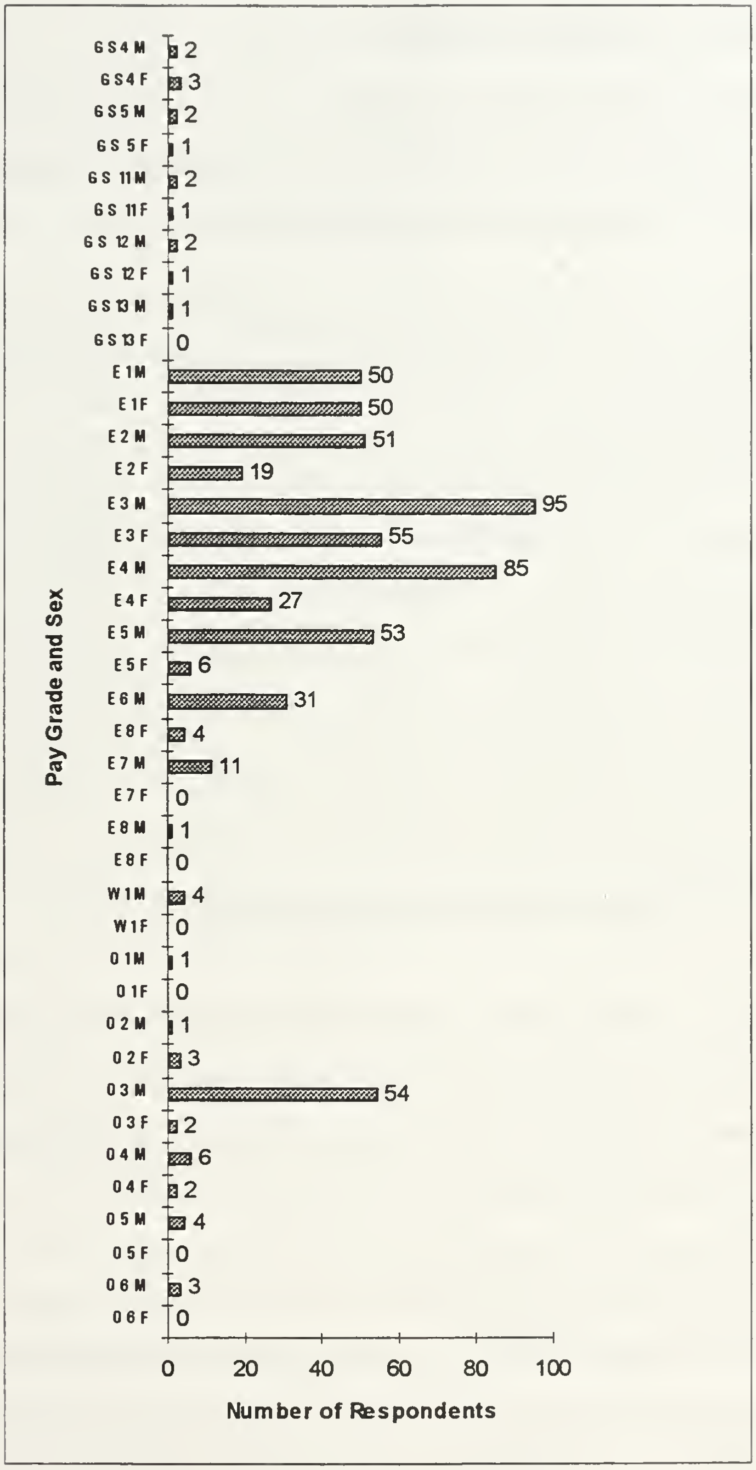

Figure 2: Number of Respondents by Subsample

B. VARIABLE CORRELATIONS

Correlations between pairs of variables are computed from the 615 observations on each question and are shown below in Table 1. Combinations that appear to be "reasonably" correlated are shown in boldface type.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Q1	1.00	**.530**	**.425**	**.332**	.251	**.353**	**.371**	.186	.105	.072	.025	.139	.167	.085
Q2		1.00	**.363**	**.352**	.185	**.309**	.291	.083	.133	.079	.069	.126	.170	.088
Q3			1.00	.265	.137	.233	.273	.175	.089	.035	.027	.006	.045	.079
Q4				1.00	.154	.240	.269	.094	.024	.051	.004	.066	.089	.073
Q5					1.00	.185	.183	**.296**	.119	-.06	.063	.036	.104	.067
Q6						1.00	**.303**	.146	.049	.081	.055	.123	.118	.139
Q7							1.00	.096	.059	-.02	-.04	.037	.084	.088
Q8								1.00	.017	.046	.071	.061	.030	.126
Q9									1.00	.260	-.04	.172	.202	.087
Q10										1.00	-.34	**.397**	**.325**	.181
Q11											1.00	-.005	.009	.039
Q12												1.00	**.342**	.220
Q13													1.00	.286
Q14														1.00

Table 1: New ASQ correlation coefficients

From this correlation matrix several possible groupings of variables are readily apparent. Most notable is the group that contains Q1, Q2, Q3, Q4, Q6, and Q7. Two other groups that are less well correlated are Q5 with Q8, and the group consisting of Q10, Q12, and Q13

C. PRINCIPAL COMPONENTS

Principal component analysis is a technique for transforming a set of original, *interrelated* variables into a set of new *uncorrelated* variables where each component is a linear combination of the original variables and the "information" contributed by each component is proportional to its variance (Afifi and Clark 1990). Thus for N original variables $x_1, x_2, \ldots, x_N$ we want to arrive at a set of new variables $C_1, C_2, \ldots, C_N$ where:

$$C_j = a_{1j}x_1 + a_{2j}x_2 + \ldots + a_{1n}x_N$$

subject to the following three constraints:

(1) The variance of $C_1 \geq$ variance $C_2 \geq \ldots \geq$ variance C_N

(2) All C_j are orthogonal

(3) For all C_j, $a^2_{1j} + a^2_{2j} + \ldots + a^2_{1N} = 1$

Prior to performing the principal components analysis the original variables are standardized (each is divided by its standard deviation) so that the principal components are found for the correlation matrix rather than the covariance matrix. According to Afifi and Clark (1990) this simplifies the analysis because: (1) The total variance of the system is now equal to the number of variables N, (2) the correlation between the i^{th} principal component and the j^{th} variable is simply $r_{ij} = a_{ij}\sqrt{\text{VAR C}_i}$, where VAR C_i is the eigenvalue of the i^{th} column. From the correlation matrix shown above as Table 1 the principal components of the data are calculated and shown below in Table 2.

In Table 2 each column is an eigenvector and the eigenvalue shown represents the variation accounted for by that eigenvector (each eigenvector is a principal component). The principal components run sequentially (one through fourteen) from left to right in descending order based on the magnitude of their eigenvalue. The row labeled "Percent" shows the percent of variation accounted for by that particular eigenvector. For example, in column one the eigenvalue, or total variation accounted for by the first principal component (PC-1) is 3.09. The total variation is equal to the number of variables, in this case 14, making both the individual and cumulative percentage of variation accounted for by PC-1 equal to 3.09/14 which we can see from Table 2 is 22.08 percent (approximately, due to rounding). Similarly in Table 2, the row labeled "CumPercent" shows the percentage of total variation accounted for by the summation of eigenvalues from column one through column fourteen. To calculate the cumulative percentage for

any column, the eigenvalue of that column and all previous eigenvalues are summed and the sum is divided by 14.

Following Afifi and Clark (1990), variables that have a correlation coefficient greater than .5 with a principal component are considered highly correlated and said to "load" on that component. For the table of eigenvectors shown below this amounts to values of $a_{ij} > .5/\sqrt{\text{VAR C}_i}$ (where C_i is column i from Table 2, and a_{ij} is the entry at the intersection of the i^{th} column and j^{th} row); these values are shown in boldface type in the body of the table. Again, several groupings of component-variable combinations are apparent. Based on Afifi and Clark's criterion we see that variables Q1, Q2, Q3, Q4, Q6, and Q7 load on PC-1. This grouping is identical to the most prominent grouping surfacing in the analysis of the correlation matrix of Table 1. In similar fashion, variables Q10, Q12, and Q13 load on PC-2, which also parallels the correlation matrix findings.

	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PC-7	PC-8	PC-9	PC-10	PC-11	PC-12	PC-13	PC-14
EigenValue:	3.09	1.88	1.23	1.06	0.95	0.83	0.81	0.76	0.70	0.66	0.60	0.57	0.44	0.41
Percent:	22.08	13.41	8.81	7.55	6.80	5.94	5.76	5.44	5.00	4.71	4.30	4.07	3.16	2.95
CumPercent:	22.08	35.49	44.30	51.85	58.65	64.60	70.35	75.80	80.80	85.51	89.81	93.89	97.05	100.0
Eigenvectors:														
Q1	**0.42**	-0.15	-0.12	0.04	0.07	0.13	-0.07	0.07	-0.29	-0.09	-0.14	-0.22	-0.71	0.30
Q2	**0.39**	-0.12	-0.15	0.22	0.19	0.17	-0.10	-0.06	-0.11	-0.24	-0.27	-0.47	0.53	-0.22
Q3	**0.32**	-0.19	-0.16	-0.03	0.06	0.46	0.43	0.06	-0.16	0.00	0.11	0.60	0.13	-0.10
Q4	**0.31**	-0.14	-0.19	0.12	-0.13	0.05	-0.24	-0.62	0.55	0.16	0.13	0.10	-0.10	-0.01
Q5	0.24	-0.14	0.35	-0.46	0.19	-0.35	-0.24	-0.25	-0.14	-0.25	-0.26	0.34	0.14	0.15
Q6	**0.33**	-0.09	0.01	0.08	-0.23	-0.26	-0.15	0.60	0.41	-0.38	0.18	0.13	-0.02	-0.12
Q7	**0.31**	-0.18	-0.19	-0.01	-0.14	-0.53	0.18	0.11	-0.21	0.61	0.08	-0.08	0.21	0.14
Q8	0.19	-0.08	0.42	-0.57	-0.22	0.37	-0.02	0.09	0.07	0.23	0.25	-0.36	0.02	-0.17
Q9	0.16	0.28	-0.01	-0.17	**0.73**	-0.13	0.32	0.09	0.38	0.13	0.01	-0.10	-0.14	-0.12
Q10	0.15	**0.54**	-0.22	-0.18	-0.09	0.20	-0.09	0.08	0.09	-0.06	0.08	-0.01	0.28	0.67
Q11	0.01	-0.25	**0.58**	0.49	0.25	0.16	-0.05	0.11	0.12	0.18	0.12	0.03	0.13	0.43
Q12	0.20	**0.43**	0.15	0.16	-0.05	0.13	-0.41	0.18	-0.07	0.42	-0.40	0.27	-0.06	-0.30
Q13	0.23	**0.39**	0.20	0.22	0.05	-0.16	-0.05	-0.24	-0.38	-0.17	0.63	0.00	-0.04	-0.19
Q14	0.18	0.26	0.35	0.16	-0.41	-0.11	**0.60**	-0.19	0.14	-0.14	-0.36	-0.08	-0.06	0.02

Table 2: Principal components

Also of interest is that Q14 is represented by PC-7. Q5 and Q8, which appeared correlated earlier, do not pass Afifi and Clark's loading criterion on any

component, however Q5 correlates with PC-1 at the r_{ij} value of .41, and Q8 with PC-3 at an r_{ij} of .46, both just slightly below the cutoff level.

1. Component Consistency

Before performing any further analysis on the principal components, verification that the apparent structure really exists must be obtained. If the components really exist then they should also be apparent when the data are divided into smaller or arbitrary sub-sets. To check the consistency of the underlying structure the data are divided using three separate schemes: (1) time, (2) number of records, and (3) random sort (each will be described in a separate paragraph to follow). To obtain "pictures" of the data structure GH' biplots are produced for the data reference set and sub-sets. Biplots project higher dimensional spaces onto lower dimensional sub-spaces: in our case the fourteen dimensional data space is projected onto a three dimensional sub-space. GH' biplots scale the principal components so that the standard deviation of each is equal to one. They are better at illustrating the variable correlations than are the standard or "JK" biplots. The rays numbered one through fourteen represent the original variables and clusters of rays indicate groups of variables that are highly correlated. All the GH' biplots shown below give views from the same perspective for ease of comparison.

a) The Reference Picture

The components and rays derived from the entire data set are used to produce the reference picture given by the GH' biplot in Figure 3. The variables' three major groupings are circled and labeled in Figure 3 below. In the following comparisons the sub-set biplots are compared to this original picture with respect to cluster composition and orientation on the X, Y, and Z axes. In all cases the clusters orient as follows: (1) group one points down and to the right and consists of Q1, Q2, Q3, Q4, Q6, and Q7, (2) group two points down and to the

left and consists of Q5, Q8, and Q11, (3) group three points up in the direction of the Y axis and consists of Q9, Q10, Q12, Q13, and Q14.

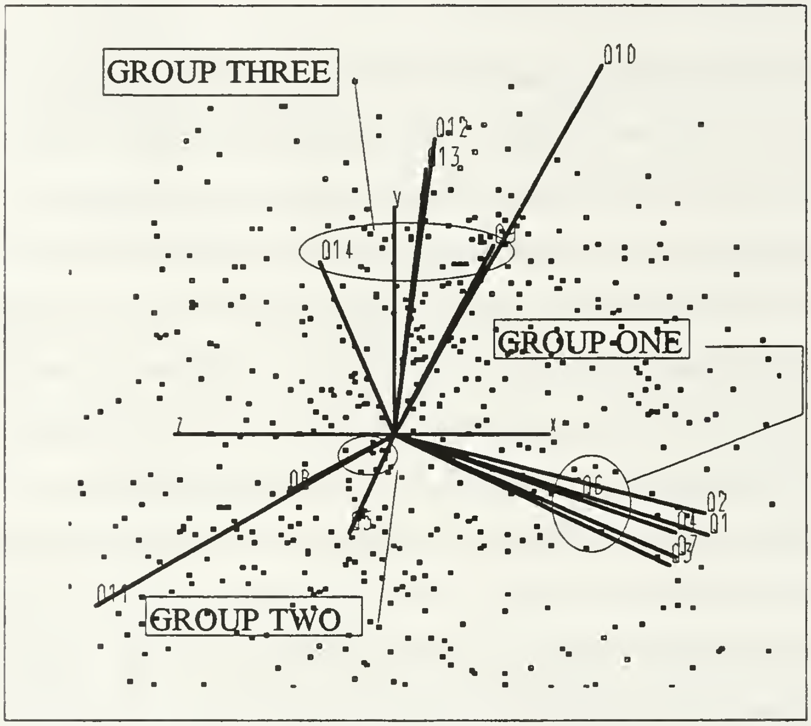

Figure 3: GH' Biplot Showing Original Component Groupings

b) Division by time

For a first look at an arbitrary division of the data, the median ASQ completion date is chosen as the dividing line. This division puts a total of 223 records in sub-set one, and the remaining 392 records in sub-set two. GH' Biplots of the two sub-sets are shown below in Figure 4 with sub-set one as Figure 4a and sub-set two as Figure 4b. It is apparent that both divisions of the data have roughly the same shape as the reference biplot. In Figure 4a we see the same three groupings of rays but with slightly more "distance" among rays within groups as compared to Figure 4b; this greater variability may be caused by the smaller number of records allocated to sub-set one.

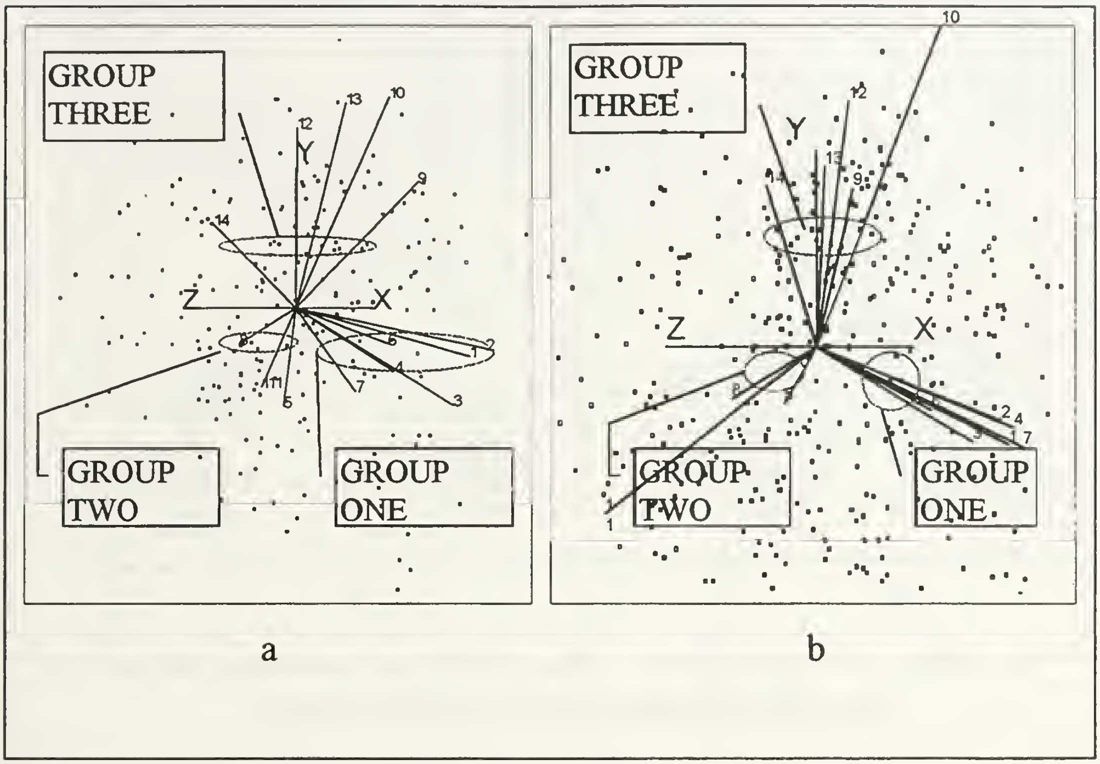

Figure 4: GH' Biplots of data divided by time

c) *Dividing data set in half*

The second arbitrary grouping scheme divides the original, unordered data in half (approximately) with 307 records in sub-set one (Figure 5a) and 308 records in sub-set two (Figure 5b). Again, GH' biplots are presented below and we see the familiar shape of the reference data set reflected in both Figure 5a and Figure 5b lending more credence to the existence of a consistent underlying structure.

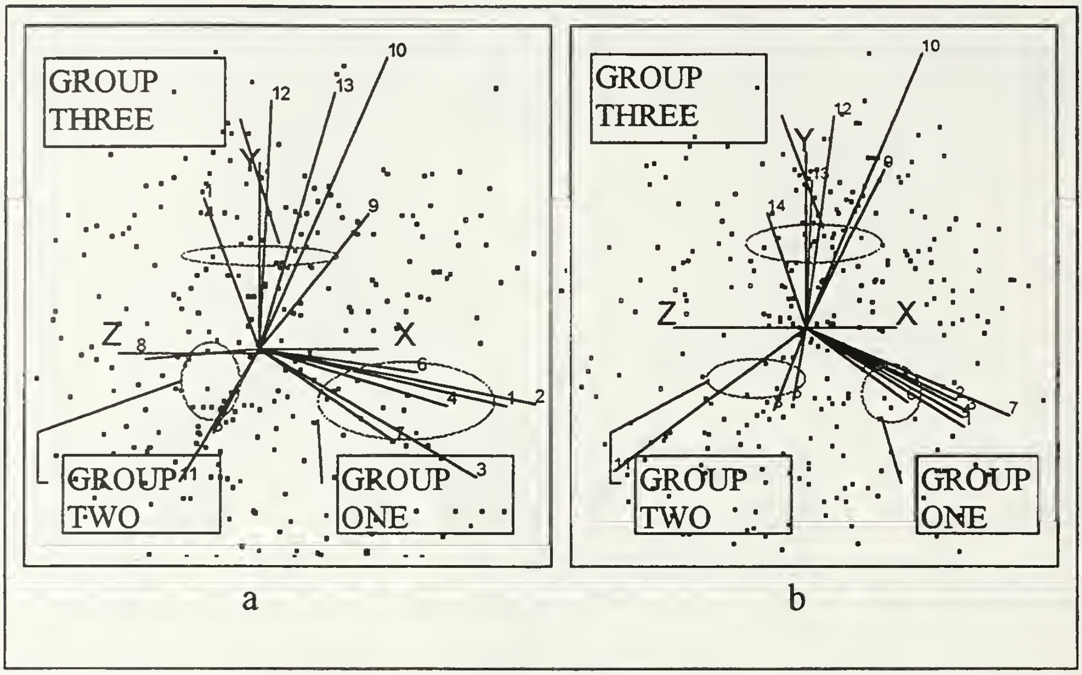

Figure 5: GH' Biplots of Data Divided in Half

d) Random Division

As a final check for consistency, the "date ordered" data are randomly separated into two groups. This separation was effected using the Excel RAND function. The division scheme is performed several times with a set of biplots created and analyzed for each distinct data division. All divisions evidenced similar shapes therefore only one set of biplots is presented below in Figure 6. Again, the familiar shape of the reference data set is readily apparent in the randomly divided data.

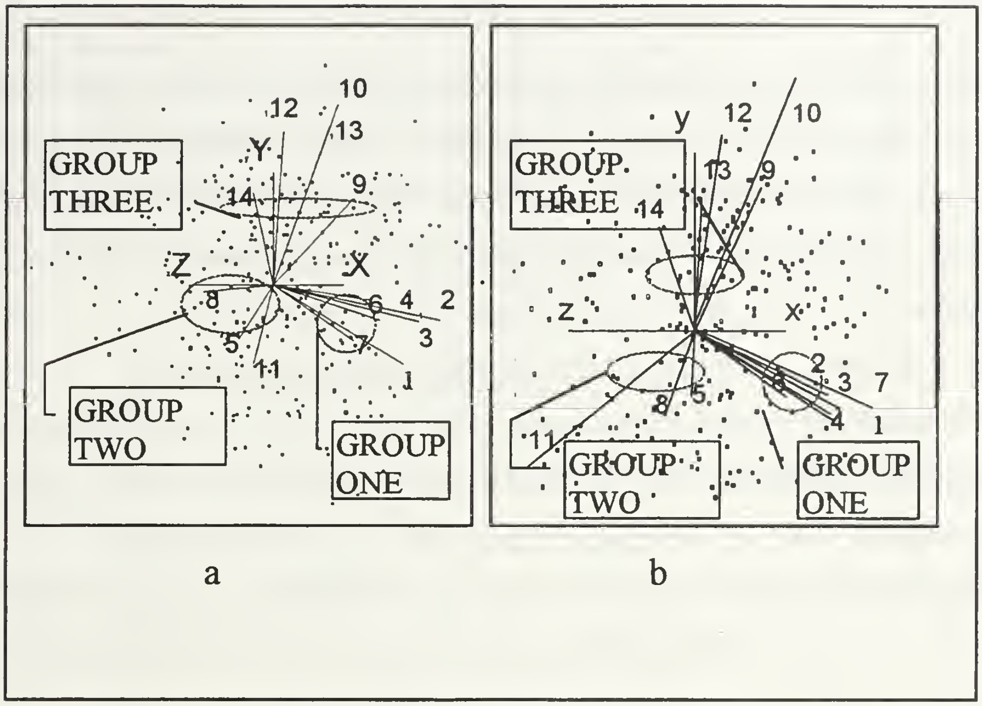

Figure 6: GH' Biplots of data divided randomly

e) Conclusions on Consistency

With three separate data division schemes yielding very similar results, the data's underlying structure is determined to be consistent and further analysis is justified.

2. Component Retention

One objective of principal component analysis is reduction of dimensionality. If reduction is to be realized certain components must be culled. Many criteria for rejecting (or keeping) components exist and the ones selected for this analysis result from work done by Kaiser(1960), Cattell(1966), Afifi and Clark(1990) Jolliffe(1972), and Dunteman (1989). Kaiser (1960) recommends, for correlation matrices, dropping components with eigenvalues less than one. Jolliffe (1972) claims, based on simulation studies, that Kaiser's "less than one" criteria is too restrictive and often throws away much information and that for a correlation matrix .7 is a better target value for eigenvalues. Cattell (1966) recommends a "scree" graph. In the scree graph, eigenvalues are plotted in decreasing order and

connected by lines. A point "k" is chosen where the connecting lines are "steep" to the left of k and "not steep" to the right of k; finally k principal components are selected. Afifi and Clark (1990) as well as Dunteman (1989) recommend retaining enough components to account for a *significant* cumulative percentage of variation; in the examples shown they used 80 percent as a guide.

Referring to Table 2, the above criteria pose several plausible combinations, all yielding similar results. Following Jolliffe (1972), Afifi and Clark (1990), and Dunteman (1989) we select nine principal components as the ninth eigenvalue is .7006 and the cumulative variation accounted for by nine eigenvectors is 80.8034 (under PC-9 in Table 2). Selecting according to Kaiser (1960) we choose only four principal components where the fourth eigenvalue is 1.06, (the fifth is .95) and the cumulative variation accounted for by four eigenvectors is 51.8535 (under PC-4 in Table 2). Cattell's scree technique results in the graph shown in Figure 7.

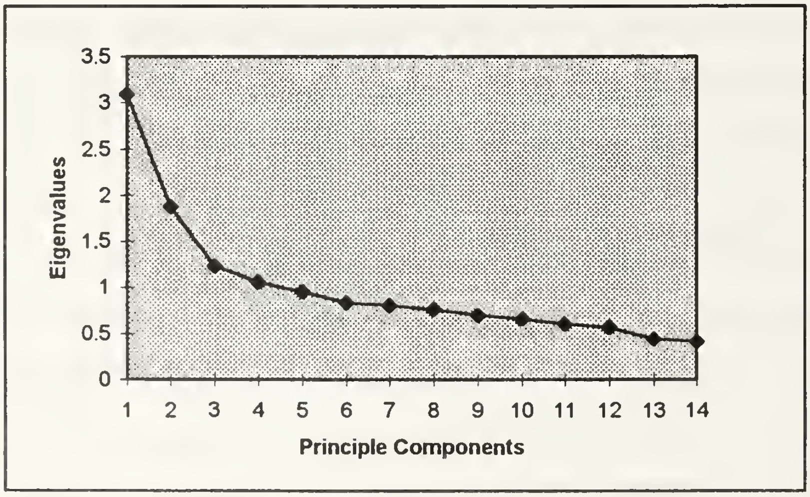

Figure 7: Scree Graph of Eigenvalues

The slope of the scree graph decreases sharply between principal components 1 and 3, and then less sharply between 3 and 6 and appears to decrease at a constant rate through the fourteenth component. Based on the scree analysis six components seem to be a reasonable choice. The eigenvalue and

cumulative percentage of variance for six components are .8318 and 64.59 respectively (under PC-6 in Table 2). Using the selection methods discussed above, a range of four to nine principal components is selected for possible retention. Given this range seven components are chosen for the following reasons:

a) Eigenvalue and Cumulative Variation

The eigenvalue and cumulative variation for the seventh component (PC-7 in Table 2) are .8062 and 70.3547 respectively; therefore, its eigenvalue is well within the range between Kaiser's 1.00 and Jolliffe's 0.7 and together with the first six components accounts for over 70 percent of the variation.

b) Interpretability

Since the choice of criterion for component retention is somewhat arbitrary, it seems reasonable to select, from within the aforementioned range of four through nine components, the number of components that seems to yield the best interpretation. Again that number is seven and the interpretation of those seven components follows.

3. Interpretation of Retained Components

Seven principal components are retained for the reasons stated above. In the context of the original variables the following interpretations are presented:

a) Component One

An excerpt from Table 2 (shown below as Table 3) demonstrates that variables Q1, Q2, Q3, Q4, Q6, and Q7 are all highly correlated ($a_{ij} > .5/\sqrt{\mathrm{VAR}\ \mathrm{C}_i}$) with PC-1.

EigenValue:	3.09
Percent:	22.08
CumPercent:	22.08
Eigenvectors:	
Q1	**0.42**
Q2	**0.39**
Q3	**0.32**
Q4	**0.31**
Q5	0.24
Q6	**0.33**
Q7	**0.31**
Q8	0.19
Q9	0.16
Q10	0.15
Q11	0.01
Q12	0.20
Q13	0.23
Q14	0.18

Table 3: Excerpt from Table 2

From Figure 1 we see that the questions listed above all have to do with the *academic* portion of the students' DLI experience. Q1 and Q2 concern the overall *instructional* program's organization, goals, and related requirements. Q4 and Q7 are about the *grading* system and the *tests*. Q3 is about *teaching team* cooperation and Q6 about official *text* materials. Therefore PC-1 is interpreted as *a measure of satisfaction with students'* ***academic environment***.

b) Component Two

Again, in Table 4 we see that Q10, Q12, and Q13 are highly correlated with PC-2.

EigenValue:	1.88
Percent:	13.41
CumPercent:	35.49
Eigenvectors:	
Q1	-0.15
Q2	-0.12
Q3	-0.19
Q4	-0.14
Q5	-0.14
Q6	-0.09
Q7	-0.18
Q8	-0.08
Q9	0.28
Q10	**0.54**
Q11	-0.25
Q12	**0.43**
Q13	**0.39**
Q14	0.26

Table 4: Excerpt from Table 2

As seen in Figure 1 the questions that load on PC-2 are *military* aspects of a student's DLI experience. Q10 deals with *barracks* living conditions, Q12 with food in the *dining facility*, and Q13 with *military training* while at DLI. Therefore PC-2 is interpreted to be *a measure of satisfaction with students' **military environment***.

c) Component Three

PC-3 appears to be highly correlated with only one question. However, that question lends itself to a unique interpretation in that it relates to government housing as opposed to barracks or dormitories. Since only one variable loads heavily on PC-3 no excerpt from Table 2 is shown here, however the variable's a_{ij} score is .5804. Since only this question is highly correlated to PC-3 and the question concerns a somewhat unique aspect applicable to a smaller percentage of students, PC-3 is interpreted to be *a measure of satisfaction with students' **non-barracks/dormitory government quarters***.

d) Components Four and Six

PC-4 and PC-6 have no variables that load on them at the $a_{ij} > .5/\sqrt{\text{VAR } C_i}$ level that have not already been used for a component with a higher overall variance. For instance, Q11 loads on PC-4 at just about the .5 level; however, Q11 has already been allocated to PC-3. PC-4 does have weak negative correlations with Q5 and Q8 which appeared to be somewhat correlated in the original variables correlation matrix shown in Table 1. This weak negative relationship may play a part in the factor analysis phase where it will be seen that Q5 and Q8 appear to form their own rotated component with an interpretation concerning audio tapes.

e) Components Five and Seven

PC-5 has one variable that is highly correlated: Q9. Q9 deals with the respondent's service unit's computer learning center. Similarly, Q14 singularly loads on PC-7. Q14 deals with the care the respondent received at the Troop Medical Clinic. Therefore, component five is interpreted as *a measure of satisfaction with students'* ***service unit's computer learning center*** and seven is interpreted *a measure of satisfaction with* ***healthcare***.

D. FACTOR ANALYSIS

The purpose of factor analysis is to find new factors that are easier to interpret in the context of the original variables (Afifi and Clark 1990). Dunteman (1989) points out that if a suitable interpretation can be made from the original principal components then there is no need to rotate them. Nevertheless, for possible enhancements to our interpretation a factor analysis is performed. For our initial factors we restrict attention to the same four through nine principal components chosen in the previous section. Various numbers of these principal components are subjected to the varimax rotation scheme to see if factor rotation contributes anything to our understanding of the data's underlying factor structure.

The varimax rotation maximizes the sum of the squared factor loadings of the retained components, producing a unique rotation matrix that when multiplied by the original matrix of eigenvectors produces a unique factor matrix. The objective is to produce factors that have some loadings near one and some near zero, thereby making them easier to interpret. The criteria for a successful factor analysis is taken from Johnson and Wiehert (1982) and is known as the "Wow" criteria:

> If, while scrutinising the factor analysis, the investigator can shout 'Wow, I understand these factors!', the application is deemed successful.

As is seen in the following interpretation the "Wow" criteria is satisfied and the rotation adds to the understanding of the data's structure.

1. Interpretation of Rotated Components

The varimax rotation scheme is applied to the candidate range of components four through nine. A discussion and interpretation of each is presented below followed by a conclusion concerning the rotation process.

a) Rotating Four Components

When four components are rotated the rotation matrix groups the questions into four distinct groups that differ only slightly from the original principal component structure. As with the original principal components analysis, Q1, Q2, Q3, Q4, Q6, and Q7 are grouped together in the rotated component one (RC-1). The interpretation of this component remains the same as in the principal component interpretation: *a measure of satisfaction with students'* ***academic environment.***

RC-2 contains all of the questions contained in PC-2 with the addition of Q14. This seems to make sense as Q14 pertains to adequacy of care received at the *Troop Medical Clinic*. PC-2 was originally interpreted: *a measure of satisfaction with a students'* ***military environment.*** The Troop Medical Clinic

is a military activity and therefore its addition to RC-2 serves to strengthen its original interpretation. Therefore RC-2's interpretation is the same as PC-2's interpretation given above.

RC-3 also follows the original principal component interpretation: *a measure of satisfaction with students'* ***non-barracks/dormitory*** *government quarters.* Q11, which deals exclusively with government housing, is highly correlated with this rotated component.

Unlike PC-4, for which no clear interpretation was discernible, RC-4 is highly correlated with Q5 and Q8. Q5 and Q8 both deal with course (and supplementary, instructor prepared) tapes' audio quality: additionally, these are the only questions that deal with course tapes. Therefore grouping these two questions together seems to add to our understanding of the data's factor structure; RC-4 is interpreted as *a measure of students' satisfaction with the audio quality of the* ***official and supplemental course tapes.***

Rotating four components suggests four convenient groupings of the variables but it should be mentioned that the four component rotation scheme leaves out one variable. Q9, concerning the students' service unit's computer learning center, is not strongly correlated with any of the four rotated components.

b) Rotating five Components

When five original components are rotated, the first four rotated components are loaded on by the same variables as in the four component scheme discussed above, and the magnitude of the loadings do not change appreciably. The major change resulting from the additional rotated component is that Q9, left out in the four component scheme, is now included and turns out to be highly correlated with RC-5. Therefore, the interpretation of the first four rotated components remains the same as in the four component scheme and RC-5 is interpreted to be *a measure of students' satisfaction with their* ***service unit's computer learning center.***

c) Rotating Six through Nine Components

The effect of adding a sixth component for rotation is to separate two variables from RC-1. Q6 and Q7 are highly correlated with RC-6. Q6 is as follows: "The official ***text*** materials were useful." Q7 reads "Course ***tests*** appropriately measured my abilities." The author can see no inherent similarity in these two questions. The *usefulness* of text materials and *measurement* abilities of tests do not seem to be intuitively related. Grouping these two questions together – separate from the other questions concerning the overall academic environment – seems to add an air of ambiguity to the notion of an underlying structure. Similar results occur from the addition of more rotated components. A seventh component strips Q14 from RC-2 and isolates the variable as RC-7. This reverses the improvement in RC-2 over PC-2. Adding an eighth rotated component captures Q4 as that eighth component, further detracting from the integrity of RC-1. Finally, a ninth component sets apart the grouping of Q5 and Q8.

2. Discussion

The factor analysis indicates that ASQ 2.0 is essentially *five* dimensional as compared to the *two* dimensions it is designed to cover. Those five dimensions are:

(1) RC-1: *a measure of satisfaction with students'* ***academic environment.***

(2) RC-2: *a measure of satisfaction with students'* ***military environment.***

(3) RC-3: *a measure of satisfaction with students'* ***non-barracks/dormitory*** *government quarters.*

(4) RC-4: *a measure of students' satisfaction with the audio quality of* ***the official and supplemental course tapes.***

(5) RC-5: *a measure of students' satisfaction with their* ***service unit's computer learning center***

For each of the five factors selected, quantitative measures are developed for use in further analysis. These quantitative measures are called “factor scores.” Afifi and Clark(1990) point out that “it is conceivable to construct factor score equations in an infinite number of ways.” The factor scores chosen here are the original variable magnitudes scaled by the factor loading coefficient of that variable on that factor. This allows the variables with the highest loadings to contribute a greater percentage to the total factor score. The factor score equations are given below where factor one is labeled “RC-1” and the remainder accordingly:

(1) $\boldsymbol{RC\text{-}1} = .753349\boldsymbol{Q1} + .724384\boldsymbol{Q2} + .631647\boldsymbol{Q3} + .626391\boldsymbol{Q4} + .557607\boldsymbol{Q6} + .629271\boldsymbol{Q7}$

(2) $\boldsymbol{RC\text{-}2} = .53546\boldsymbol{Q10} + .70461\boldsymbol{Q12} + .70036\boldsymbol{Q13} + .67486\boldsymbol{Q14}$

(3) $\boldsymbol{RC\text{-}3} = .914917\boldsymbol{Q11}$

(4) $\boldsymbol{RC\text{-}4} = .71238\boldsymbol{Q5} + .832315\boldsymbol{Q8}$

(5) $\boldsymbol{RC\text{-}5} = .849172\boldsymbol{Q9}$

III. FACTOR CENTRAL TENDENCY ANALYSIS

This chapter presents analysis investigating the effects of sex, military rank, and DLPT score on student satisfaction. DLI's Research and Analysis Division is interested in trend analysis across various sub-scales; specifically, questions whether student sex, military rank, or DLPT score affect student satisfaction levels are considered here. The rotated component scores developed in Chapter II are used as quantitative measures of student satisfaction.

A. NON-PARAMETRIC METHODOLOGY

Effects of sex, pay grade, and DLPT score on student satisfaction are explored using factor scores as response variables. Some of the groupings have small numbers of observations associated with them, making accurate distributional determinations unlikely; therefore, non-parametric comparisons of central tendency are employed, avoiding the normality assumption necessary for standard techniques. The data generation mechanism (ASQ's taken from seven different schools with small groups of students taught by various teaching teams of six instructors that are not deliberately kept intact from one class to the next) provides a defensible guard against serial and auto-correlation; however, the random sampling hypothesis is untenable and this analysis suffers to the extent that it is violated.

1. Tests Employed

The object of this analysis is to determine if a factor's central tendencies are the same across all groups. Mean (and median) scores for all five rotated components are tested using three different non-parametric tests: (1) Wilcoxon Rank Sum Test (Kruskal-Wallis with more than two groups), (2) Median Test (number of points above median), and (3) Van der Waerden Test (normal Quantiles). In addition, the data are tested for homoscedasticity using four different tests: (1) O'Brien, (2) Brown-Forsythe, (3) Levene, and (4) Bartlett. For handling cases of heteroscedasticity the Welch Anova is employed.

2. Rotated Component Scores of Zero

In all cases, rotated component scores of zero are present. The extent to which they appear and the effect they have on the analysis varies by question. Table 5 depicts the incidence rates of "0" for all five rotated components.

ROTATED COMPONENT SCORES OF ZERO			
COMPONENT	NUMBER OF ZEROS	NUMBER OF RESPONSES	PERCENT OF ZEROS
RC-1	3	615	.004878
RC-2	33	615	.053659
RC-3	391	615	.635772
RC-4	11	615	.017886
RC-5	256	615	.41626

Table 5: Incidence of Zero Scores for Rotated Components

a) RC-1, RC-2 and RC-4

RC-1, RC-2, and RC-4 all have six percent or fewer zeros, indicating that the majority of students answer the questions associated with those factors. Nevertheless, to get a zero score for any of RC-1, RC-2 or RC-4 a student has to respond "No opinion or not applicable" to at least two questions, and in the case of RC-1 that response must be provided for six questions. The notion that a student in a military-academic environment either has "no opinion" about the school or the military, or that the questions concerning the functioning of that environment are "not applicable" to the student seems implausible, and it is possible students select zero for some other unknown reason. It is noted here that with the high positive response rates for these rotated components the inclusion, or exclusion, of the zeros matters little, and since their inclusion is conservative in nature they are kept in for this analysis.

b) RC-3 and RC-5

RC-3 and RC-5, shown in Table 5, have significant incidence rates for zero responses. This is to be expected because RC-3 and RC-5 are both driven

by one question each. RC-3 is uniquely associated with Q11, which concerns only non-barracks/dormitory government housing, and RC-5 concerns the students' service unit's computer learning center. Since these questions do not pertain to all students the notion of "not applicable" seems plausible here; therefore, the zero responses are eliminated.

B. EFFECTS OF DLPT SCORE ON STUDENT SATISFACTION

In all three DLPT cases, DLPT score means are found to be significantly different with respect to RC-1 (academic satisfaction) and in the case of DLPTS a significant difference exists across RC-5. A graphical depiction of central tendencies for DLPTL, DLPTR, and DLPTS across RC-1 is shown below as Figure 8.

In Figure 8 quantile boxes are shown to illustrate the response variables' spread and medians; additionally, the jagged lines illustrate the means and are connected to highlight the upward trend. The straight horizontal line depicts the overall mean.

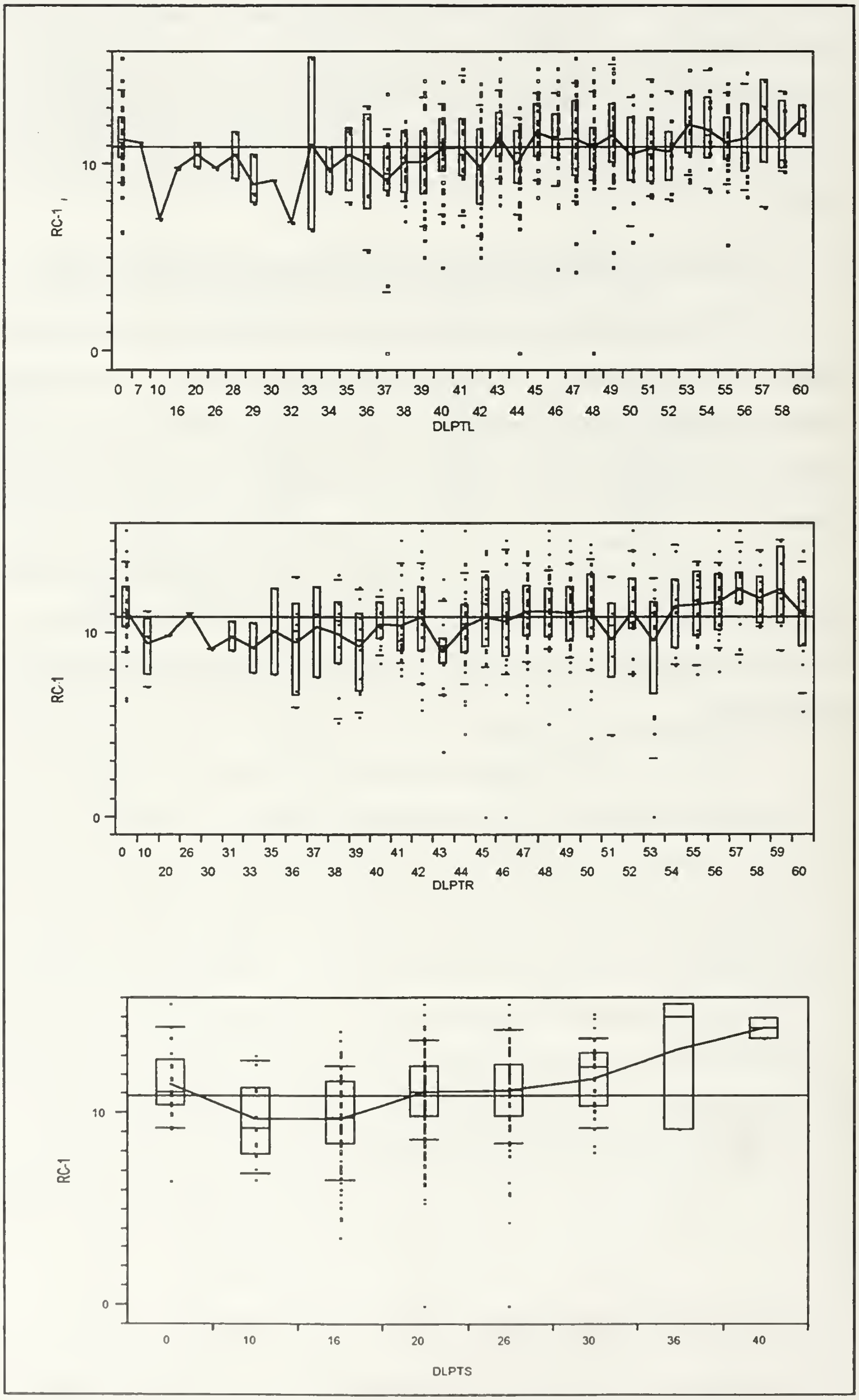

Figure 8: RC-1 vs. DLPTL, DLPTR, and DLPTS

Looking at Figure 8 above it appears that there exists an upward trend across all three DLPT's indicating that higher scoring students tend to be more satisfied with DLI's academic environment The test results for RC-1, across the three DLPT's, are presented below in Table 6. The *p*-values shown in the table body indicate the probability of obtaining, by random chance alone, a χ^2 value greater than the one calculated, if in fact the distributions across the factor level all have the same center. *P*-values below the .05 level are usually considered ample evidence that the distributions do not have the same center. With the exception of the Median test for DLPTL, all values are well below the .05 level. In all three cases, the DLPT's heteroscedasticity results indicate that the variances are the same across all levels.

	RC-1		
	DLPTL	DLPTR	DLPTS
Kruskal-Wallis	.0014	.0007	<.0001
Median	.1689	.0174	.0003
Van der Waerden	.0009	.0012	<.0001

Table 6: Non-parametric Results for DLPT's vs. RC-1

In addition to the significant finding for RC-1, it appears that students who score higher on DLPTS tend to have a higher opinion of their service unit's computer learning center. Test results, verifying the difference in means for DLPTS vs. RC-5, are presented below in Table 7,. There was no indication of heteroscedasticity therefore the Welch Anova was not calculated.

TEST	RC-5
Kruskal-Wallis	.0019
Median	.0046
Van der Waerden	.0018

Table 7: Test Results for DLPTS vs. RC-5

Although the test results shown in Table 7 support a difference in means, small numbers of observations in the groups making up the "tails" of the sub-scale DLPTS, make the notion of a trend somewhat questionable.

C. EFFECTS OF PAY GRADE ON STUDENT SATISFACTION

It is noted here that *military* rank is not the only possible treatment level since data from GS employees are also available in the data base. However, RC-2, RC-3, and RC-5 all have direct military connotations: RC-2 is interpreted as *a measure of satisfaction with students' **military environment**;* RC-3 is *a measure of satisfaction with students' non-barracks/dormitory **government quarters**;* RC-5 is *a measure of students' satisfaction with their **service unit's** computer learning center.* In view of the above RC-2, RC-3 and RC-5 are considered with only military personnel; conversely RC-1 and RC-4 are strictly academically oriented and include the GS data

The non-parametric tests for central tendency with respect to *military rank* indicate that only RC-2 means differ significantly across among ranks. With respect to heteroscedasticity, RC-2 is the only factor that indicates significant differences in variances across treatment levels and the Welch Anova result of <.0001 still confirms the difference in central tendency. As previously stated, results for RC-2 are computed without the GS data but with the zero values in the data. To further investigate the nature of the dissimilarities among means for *military rank* two more variations are examined and they are as follows: (1) military rank *without the zero values*, (2) military rank *without zeros or levels with fewer than ten observations.* With these modifications, the test results for RC-2

continue to indicate that the null hypothesis should still be rejected; therefore, it is concluded that significant differences in satisfaction levels exist for various ranks. A graphical display of the measures of central tendency for rank versus RC-2 with all ranks and zeros included is presented below in Figure 9.

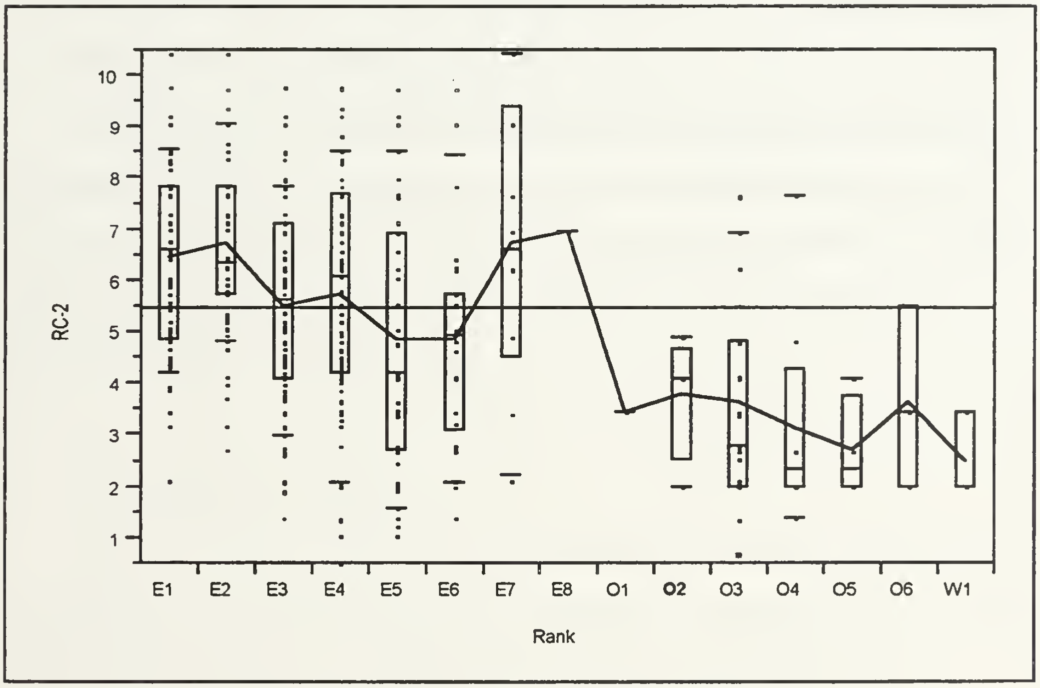

Figure 9: RC-2 versus Military Rank

At first glance it appears that there exist two general “levels” for the means: (1) enlisted mean at about 5.5 and (2) officer mean at about three. However, this is not necessarily the case. It is noted here that pay grades E8 and O1 have only one observation each and that O2, O4, O5, and O6 all have fewer than ten observations each. When the Tukey Kramer Honest Significant Difference (HSD) test is employed we find that there exist similarities from officer to enlisted and differences within the enlisted group. The interested reader is referred to Appendix A, the matrix of HSD’s where positive values indicate pairs of means that are classified as significantly different by that test.

D. EFFECTS OF SEX ON STUDENT SATISFACTION LEVELS

In this case the treatment, *sex*, has two nominal levels, *male* and *female*. It appears that neither males nor females evidence a higher level of satisfaction for any of the factors – there are no significant results from the non-parametric tests for central tendency.

IV. CONCLUSIONS/RECOMMENDATIONS

This chapter provides conclusions concerning the results from the various analyses performed in this thesis. Recommendations for possible use of the factor scores and suggestions for further study are also provided.

A. PRINCIPAL COMPONENT ANALYSIS

Although the principal components found here are interpretable, it is not recommended that their interpretations be used to describe the dimensions in the data. The principal components are useful for selecting initial factors for rotation; however, in this case, the rotated components provide a more thorough *and* intuitively defensible interpretation.

B. FACTOR ANALYSIS

The factor analysis performed here is deemed successful, and the author has a high degree of confidence in the interpretations provided for the five rotated components chosen. It is recommended that the two dimensional ASQ 2.0 summary report currently used at DLI be modified to include the additional dimensions described in Chapter II of this thesis. The variables that load on RC-3, RC-4, and RC-5 are better correlated with those factors than with the two factors from DLI's original design (academic and military).

It is recommended that a similar analysis be performed on the ASQ 1.0 data. If the same factors are determined to exist in that larger data set, the issue of trends across the sub-scales (sex, pay grade, and DLPT) can be more thoroughly explored, due to the larger number of observations that exist for ASQ 1.0. Additionally, this would allow the possible combination of the data bases, or at least a portion of them, yielding larger numbers of observations for any future studies of this nature.

It is further recommended that DLI consider modifying its ASQ response set to include a "central scale" variable such as "neither agree nor disagree." This

may help eliminate some of the “0” responses that may occur because respondents falsely believe that checking “no opinion” is a center scale response akin to the suggested “neither agree nor disagree.”

C. FACTOR CENTRAL TENDENCIES

The analysis in this section represents a good start toward a thorough investigation into trends in student satisfaction based on other population characteristics. Obviously sex, pay grade, and DLPT are not the only sub-scales worthy of consideration. It is recommended that further analysis be done in this area. Other areas of possible interest are the different schools/departments, or possibly students’ services. Exploration of a similar nature into these and other areas will allow DLI to further their knowledge of their student population, better equipping them to succeed in their goal of continuous quality improvement.

APPENDIX

Means Comparisons

Dif=Mean[i]-Mean[j]	E8	E7	E2	E1	E4	E3	E5	E6	O2	6	O3	O1	O4	O5	W1
E8	0.00000	0.23134	0.24260	0.51912	1.22942	1.46972	2.11618	2.12875	3.19344	3.3261	3.34689	3.53406	3.81710	4.26630	4.48487
E7	-0.23134	0.00000	0.01126	0.28778	0.99809	1.23839	1.88484	1.89741	2.96210	3.0947	3.11555	3.30272	3.58576	4.03496	4.25354
E2	-0.24260	-0.01126	0.00000	0.27652	0.98682	1.22713	1.87358	1.88615	2.95084	3.0831	3.10429	3.29146	3.57450	4.02370	4.24227
E1	-0.51912	-0.28778	-0.27652	0.00000	0.71030	0.95061	1.59706	1.60963	2.67432	2.8069	2.82777	3.01494	3.29798	3.74718	3.96575
E4	-1.22942	-0.99809	-0.98682	-0.71030	0.00000	0.24030	0.88676	0.89933	1.96402	2.0968	2.11747	2.30464	2.58768	3.03687	3.25545
E3	-1.46972	-1.23839	-1.22713	-0.95061	-0.24030	0.00000	0.64646	0.65903	1.72372	1.8568	1.87716	2.06434	2.34738	2.79657	3.01515
E5	-2.11618	-1.88484	-1.87358	-1.59706	-0.88676	-0.64646	0.00000	0.01257	1.07726	1.2093	1.23071	1.41788	1.70092	2.15012	2.36869
E6	-2.12875	-1.89741	-1.88615	-1.60963	-0.89933	-0.65903	-0.01257	0.00000	1.06469	1.1975	1.21814	1.40531	1.68835	2.13754	2.35612
O2	-3.19344	-2.96210	-2.95084	-2.67432	-1.96402	-1.72372	-1.07726	-1.06469	0.00000	0.1326	0.15345	0.34062	0.62366	1.07285	1.29143
O6	-3.32611	-3.09477	-3.08351	-2.80699	-2.09668	-1.85638	-1.20993	-1.19735	-0.13266	0.0000	0.02078	0.20795	0.49099	0.94019	1.15877
O3	-3.34689	-3.11555	-3.10429	-2.82777	-2.11747	-1.87716	-1.23071	-1.21814	-0.15345	-0.0208	0.00000	0.18717	0.47021	0.91941	1.13798
O1	-3.53406	-3.30272	-3.29146	-3.01494	-2.30464	-2.06434	-1.41788	-1.40531	-0.34062	-0.2075	-0.18717	0.00000	0.28304	0.73224	0.95081
O4	-3.81710	-3.58576	-3.57450	-3.29798	-2.58768	-2.34738	-1.70092	-1.68835	-0.62366	-0.4909	-0.47021	-0.28304	0.00000	0.44920	0.66777
O5	-4.26630	-4.03496	-4.02370	-3.74718	-3.03687	-2.79657	-2.15012	-2.13754	-1.07285	-0.9409	-0.91941	-0.73224	-0.44920	0.00000	0.21858
W1	-4.48487	-4.25354	-4.24227	-3.96575	-3.25545	-3.01515	-2.36869	-2.35612	-1.29143	-1.1587	-1.13798	-0.95081	-0.66777	-0.21858	0.00000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q*

3.40672

Abs(Dif)-LSD	E8	E7	E2	E1	E4	E3	E5	E6	O2	O6	O3	O1	O4	O5	W1
E8	-9.77424	-7.01743	-6.71802	-6.44294	-5.71423	-5.46501	-4.85357	-4.88358	-4.53377	-4.65452	63197	-6.24018	-3.51358	-3.46092	-3.49576
E7	-7.01743	-3.09088	-2.32523	-2.05300	-1.28735	-1.01983	-0.47872	-0.58889	-1.12675	-1.45489	72528	-3.94605	0.30738	-0.05390	-0.29612
E2	-6.71802	-2.32523	-1.16824	-0.90028	-0.07564	0.22455	0.65210	0.44139	-0.60223	-0.99142	-83188	-3.66916	0.99509	0.47062	0.16735
E1	-6.44294	-2.05300	-0.90028	-1.18530	-0.36156	-0.06193	0.36739	0.15794	-0.88158	-1.27040	-54750	-3.94712	0.71468	0.19128	-0.11163
E4	-5.71423	-1.28735	-0.07564	-0.36156	-0.94491	-0.63673	-0.23398	-0.46132	-1.55570	-1.94918	-94143	-4.63901	0.05442	-0.48284	-0.79042
E3	-5.46501	-1.01983	0.22455	-0.06193	-0.63673	-0.80344	-0.41768	-0.65539	-1.77838	-2.17417	-75494	-4.87040	-0.16136	-0.70553	-1.01541
E5	-4.85357	-0.47872	0.65210	0.36739	-0.23398	-0.41768	-1.27250	-1.47557	-2.49367	-2.88058	-09075	-5.55187	-0.90304	-1.42082	-1.72181
E6	-4.88358	-0.58889	0.44139	0.15794	-0.46132	-0.65539	-1.47557	-1.67627	-2.58865	-2.96528	-31208	-5.60702	-1.02752	-1.51580	-1.80652
O2	-4.53377	-1.12675	-0.60223	-0.88158	-1.55570	-1.77838	-2.49367	-2.58865	-4.88712	-5.14603	43523	-7.38659	-3.60871	-3.81427	-3.98726
O6	-4.65452	-1.45489	-0.99142	-1.27040	-1.94918	-2.17417	-2.88058	-2.96528	-5.14603	-5.64316	08522	-7.77268	-4.18807	-4.33850	-4.48439
O3	-3.63197	0.72528	1.83188	1.54750	0.94143	0.75494	-0.09075	-0.31208	-3.43523	-4.08522	36867	-6.79169	-2.15802	-2.66927	-2.96802
O1	-6.24018	-3.94605	-3.66916	-3.94712	-4.63901	-4.87040	-5.55187	-5.60702	-7.38659	-7.77268	79169	-9.77424	-7.04764	-6.99498	-7.02982
O4	-3.51358	0.30738	0.99509	0.71468	0.05442	-0.16136	-0.90304	-1.02752	-3.60871	-4.18807	-15802	-7.04764	-3.45571	-3.78317	-4.01129
O5	-3.46092	-0.05390	0.47062	0.19128	-0.48284	-0.70553	-1.42082	-1.51580	-3.81427	-4.33850	-66927	-6.99498	-3.78317	-4.88712	-5.06011
W1	-3.49576	-0.29612	0.16735	-0.11163	-0.79042	-1.01541	-1.72181	-1.80652	-3.98726	-4.48439	-96802	-7.02982	-4.01129	-5.06011	-5.64316

Positive values show pairs of means that are significantly different

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